Visions of Futures Past

"**Space travel is utter bilge**"

- **Dr. Richard van der Riet Woolley** (one year before Sputnik 1)

" The secrets of flight will not be mastered within our lifetime, not within a thousand years."

- **Wilbur Wright** (1901)

" Heavier than air flying machines are impossible, X-rays are a hoax."

- **William Thomson (Lord Kelvin)**
President of London's Royal Society (1895-1904)

Typical question from the public:

"When can we build something like this?"

Answer:

"This is not in the *foreseeable* future. Today it is still unknown ***if*** such visions are even achievable ...

but …

new possibilities continue to emerge from science. NASA established the '***Breakthrough Propulsion Physics Project***' to pursue these possibilities."

NASA
Breakthrough Propulsion Physics Project

and the

Revolutionary Aeropropulsion Concepts Workshop

Marc G Millis
Glenn Research Center, Cleveland Ohio
2001 - June

Breakthrough Propulsion Physics Project

What does ***BPP*** have to do with ***Aero*** propulsion?

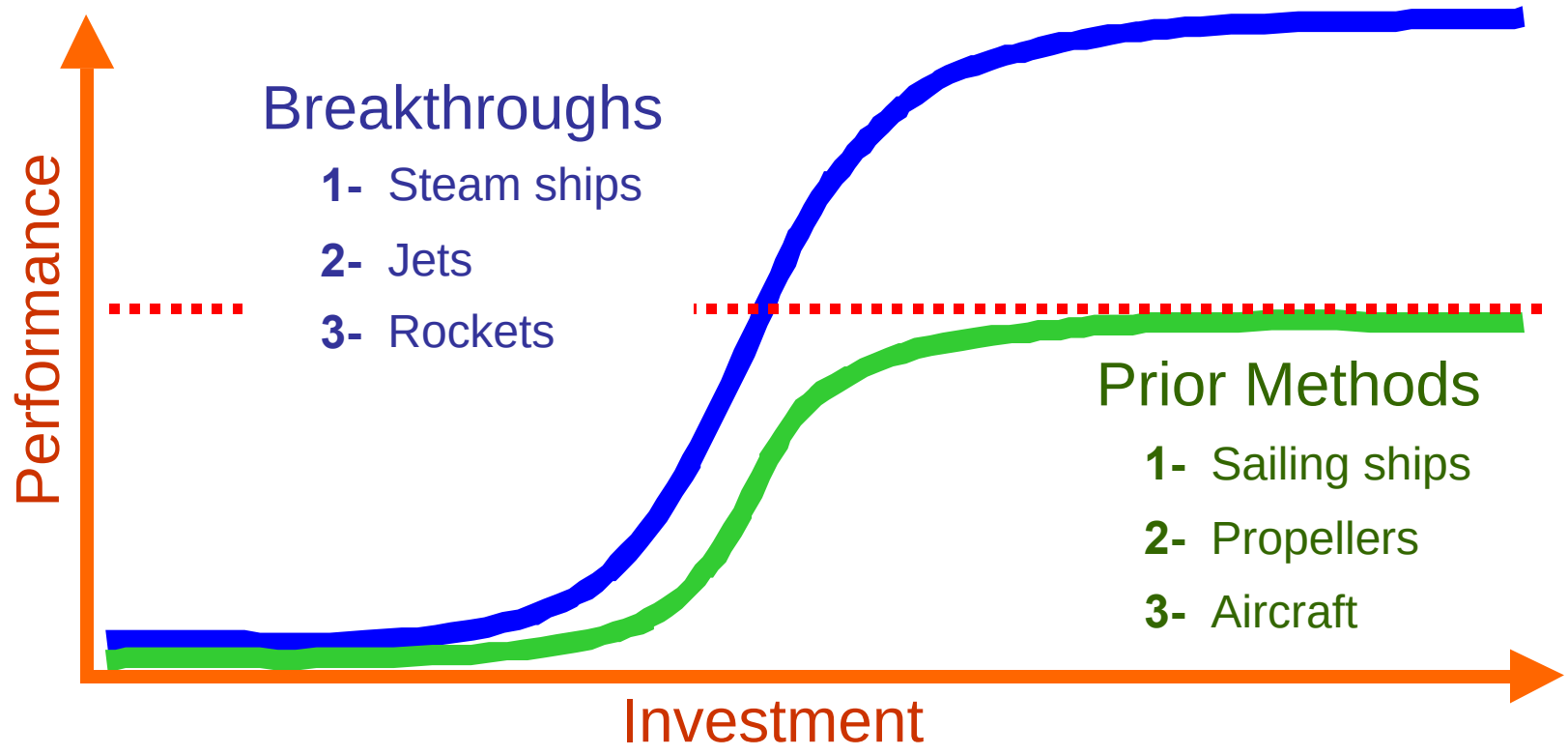
1. Lessons on being Visionary ***and*** Credible
2. Rules of Engagement
3. Space Propulsion Physics equally applies to Aero

Breakthrough Propulsion Physics Project

Recognizing a Pattern from Historic Breakthroughs

(adapted from Foster, 1986)

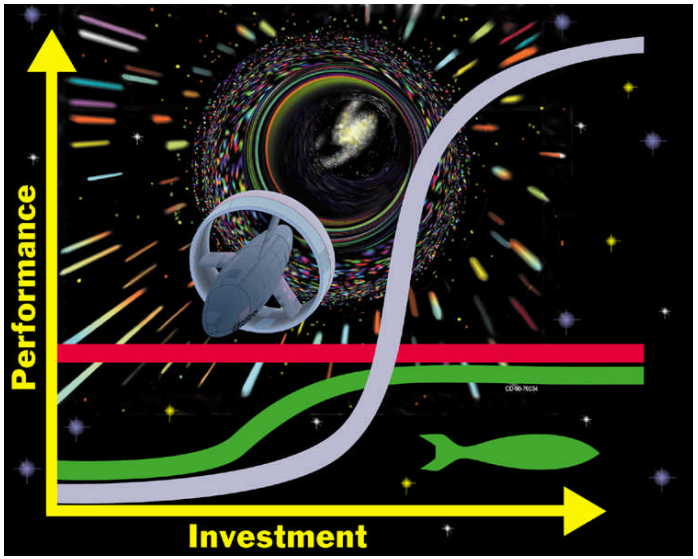
*To **exceed** the **limits** of **existing methods**, seek out entirely **different methods**.*



Breakthrough Propulsion Physics Project

Project Objective

Produce incremental, credible, and measurable progress toward conquering the ultimate breakthroughs needed to revolutionize space travel and enable interstellar voyages ...

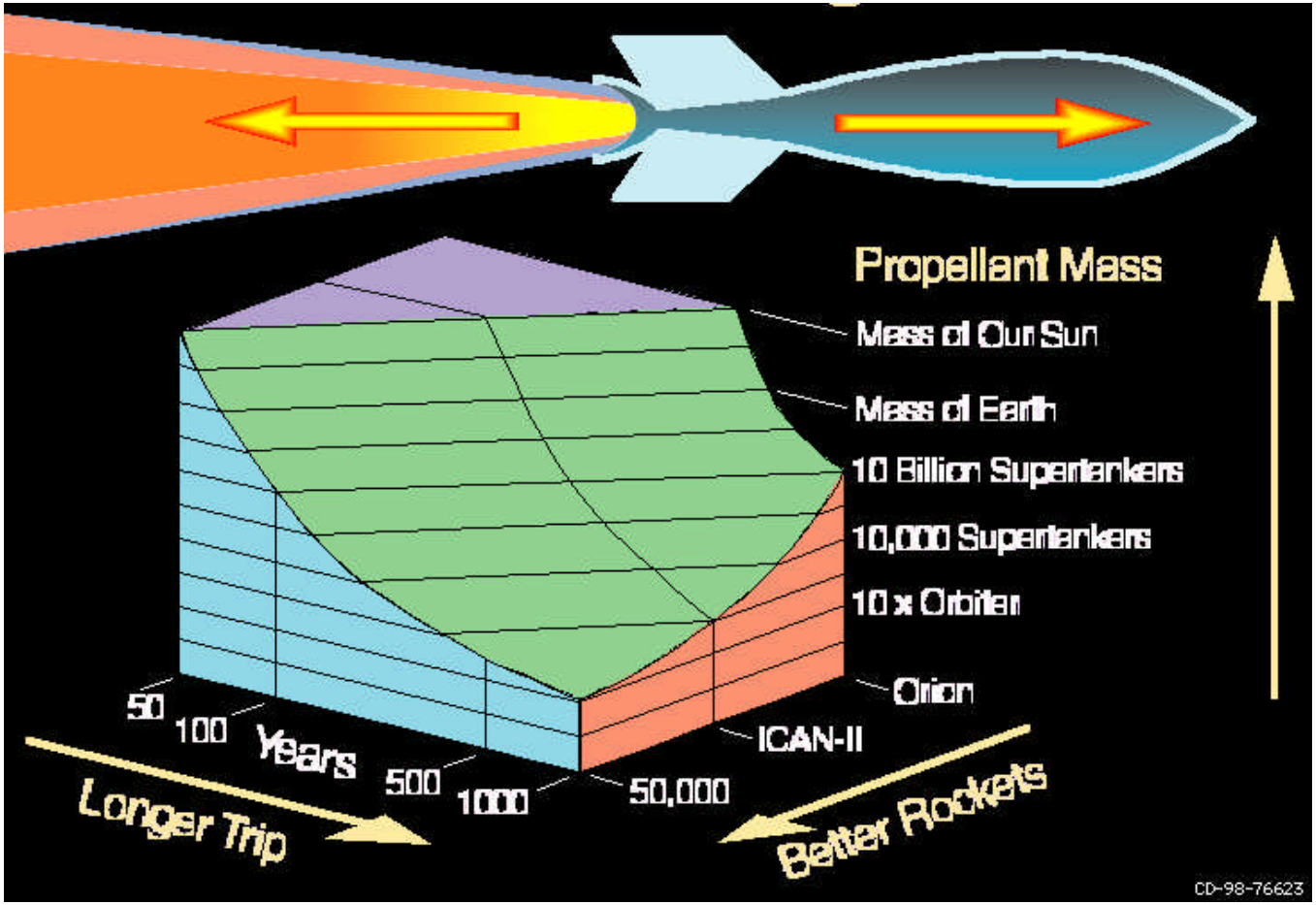


… by advancing ***science*** to provide new foundations for breakthrough technology.

Breakthrough Propulsion Physics Project

Fundamental Limit of Rockets - PROPELLANT

(example: Propellant required to fly mass of Shuttle Orbiter past 4.3 Light-years)



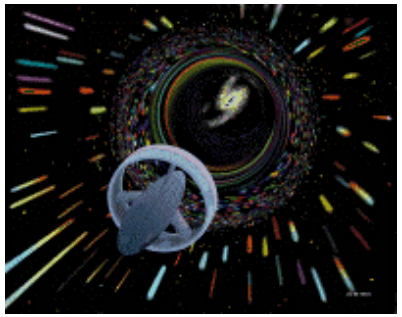
Marc G. Millis

Breakthrough Propulsion Physics Project

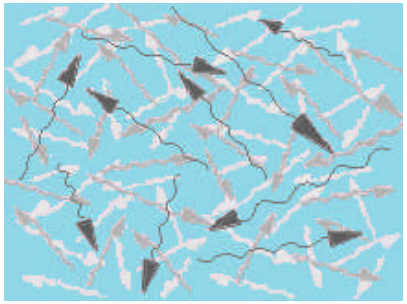
Emerging Clues

Just a ***few*** samples of provocative developments from recent scientific journals

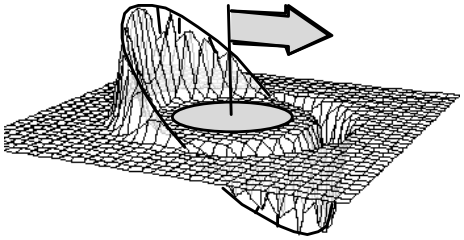
"Wormholes"



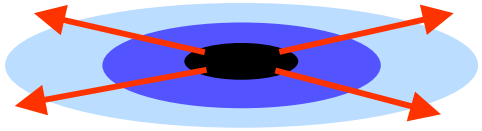
Quantum vacuum energy



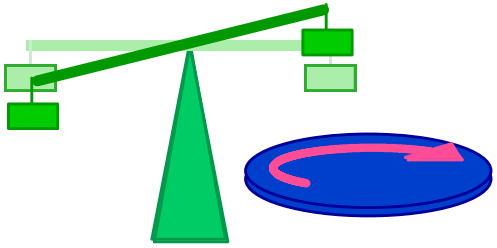
"Warp Drives"



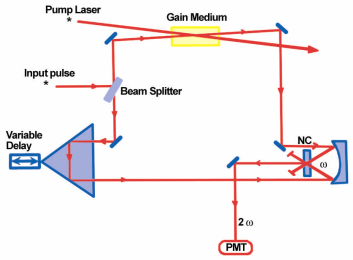
Anomalous expansion rate for the universe



Anomalous gravity effects with superconductors



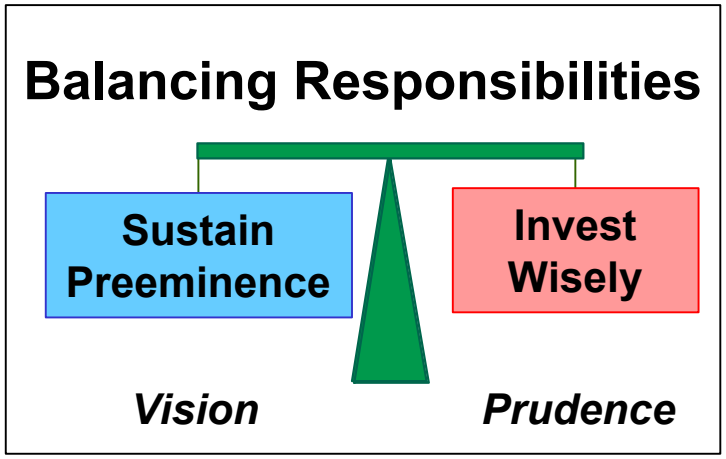
Superluminal quantum tunneling



Breakthrough Propulsion Physics Project

Project Approach

- "Success" defined as "**acquiring reliable knowledge**" (*rather than "achieving a breakthrough"*).
- Focus on ***immediate*** make-or-break issues, unknowns, or curious effects.
- Explore **multiple, divergent** research topics simultaneously.



- Sustain progress as a **series of** short-term, **incremental tasks**.
- Measure progress using the **scientific method**.
- Consider **visionary** speculations, yet tempered with **credible** methods and foundations.

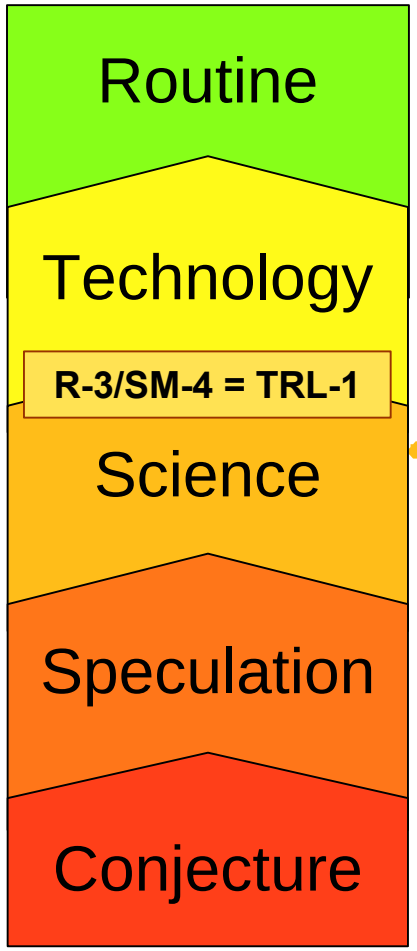
Breakthrough Propulsion Physics Project

BPP Research Selection Process

- **Selection Criteria developed / concurred by key players**
- **2-Stage Review Process**
  - **Peers numerically grade proposals**
    - Minimum of 4 reviews per proposal
    - Multiplicative, mandatory criteria
  - **Customer team reviews scores to select winners**
- **Reviewers do NOT judge feasibility, instead judge:**
  - **Project Relevance**
  - **Credibility** (*reliable* results upon which to make future decisions)
  - **Resources**
- **In-house work will be subject to same review process**

Breakthrough Propulsion Physics Project

Measuring Pre-Technology Progress



First, specify the degree of relevance of the emerging science, and then specify the progress achieved within this relevance using the **Scientific Method** levels.

Relevance of science topic (as readiness levels):

R-3 Directly relevant to a technologically desired effect
R-2 Critical make-break issue underlying the desired effect
R-1 Underlying general physics

Scientific Method (as readiness levels):

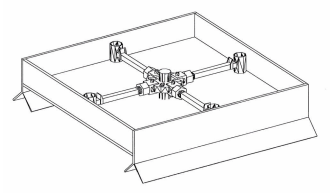
SM-4 Hypothesis empirically confirmed / dismissed
SM-3 Hypothesis proposed
SM-2 Data collected
SM-1 Problem formulated (identify relevant knowledge gaps)
SM-Ø Pre-science:
- Anomalous effect noted, or
- Correlation between goal & knowledge recognized.

Marc G. Millis

Breakthrough Propulsion Physics Project

Research Tasks

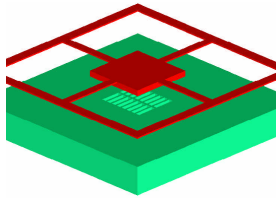
Results to be presented at the July 2001 Joint Propulsion Conference



BPP NRA

Cramer, U. of Wash. WA

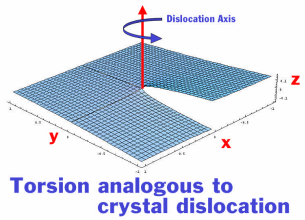
Transient Inertia



BPP NRA

Maclay, Quantum Fields LLC

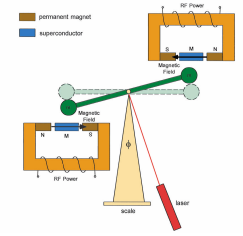
Quantum Energy



BPP NRA

Ringermacher, Wash. U, MO

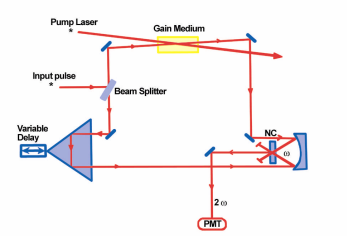
EM Torsion



BPP NRA

Robertson MSFC, AL

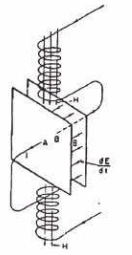
YBCO Anomaly



BPP NRA

Mojahedi, Univ NM

QM Tunneling



WV Earmark

Corum, Inst. Software Res.

Heaviside Force

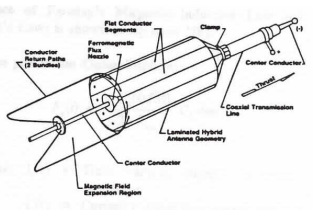
Bound State Energies of Lowest Two Deep Dirac Levels

State	n	ℓ	j	Binding Energy (mc^2-E) (eV)
$2s_{1/2}$	2	0	$\frac{1}{2}$	509,134
$2p_{1/2}$		1		
$4p_{3/2}$	4	1	$\frac{3}{2}$	510,066
$4d_{3/2}$		2		

OAI Grant

Deck, U. Toledo, OH

Deep Dirac Energy



GRC In-House

Fralic, GRC, OH

Thrusting Antenna

Breakthrough Propulsion Physics Project

What's Next

- Interim results to be presented at 2001 Joint Propulsion Conference
- Establishing BPP Research Consortium through the Ohio Aerospace Institute
- Next research solicitation this summer/fall
- Physics Community participation increasing
  (Attributed to successful blend of vision and credibility)
- Valuable lessons gained from failed approaches, and...

If 1 works...

Breakthrough Propulsion Physics Project

Vision with Credibility

- No jumping to conclusions; supportive nor dismissive
- Open minded to possible successes and impossibilities
- Convert *objections* into research *objectives*

Visionary		Credible
- Entertain that it can be done		- Be *constructively* skeptical
- Imagine the possibilities	+	- Identify unsolved physics
- Draw on inspirations		- Build on known science
- Pattern after past successes		- Aim toward *testable* concepts
		- use scientific method

Breakthrough Propulsion Physics Project

Rules of Engagement

Responding to New Ideas

1. No scoffing at presenter. Remember that every breakthrough started as an incomplete, crazy idea.

2. Use "**PINS**" sequence:
   - 1st Identify what is **P**ositive.
   - 2nd Identify what is **I**nteresting.
   - 3rd Identify what is **N**egative, AND
   - 4th **S**uggest ways to overcome flaws. Give suggestion in writing later.

3. Feel free to add ideas.

Presenting New Idea

1. No scoffing at critics. Remember skepticism is a normal, necessary part of shaping ideas into products.

2. Seek constructive suggestions to further advance the idea. Shape *objections* into *objectives.*

3. Be open to adapt ideas to take advantage of new information.

HUMOR is Constructive!